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TITLE: RADIO COMMUNICATION EQUIPMENT

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INVENTOR-INFORMATION:
NAME
TOMOTA, IKUO
HANAZAWA, TETSUO

ASSIGNEE-INFORMATION:
NAME COUNTRY
NIPPON TELEGR & TELEPH CORP <NTT> N/A

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APPL-DATE: July 28, 1993

INT-CL (IPC): H04Q007/36, H04B007/26

ABSTRACT:

PURPOSE: To establish frame synchronization among radio base stations for performing communication by a TDMA-TDD system.

CONSTITUTION: Information for indicating the position of a slot inside a frame is inserted to the slot of control signals transmitted from the radio base station 12. In the radio base station 13 for performing the frame synchronization, the control signal transmission timing of the present station is synchronized with the reception timing of the control signals and the frame synchronization is established corresponding to the position of the slot of the reception control signals inside the frame.

DERWENT-ACC-NO: 1995-121137

DERWENT-WEEK: 199516

TITLE: Radio communication apparatus for digital cordless telephones - achieves synchronisation by transmitting information regarding transmission slot of frame in control signal, transmitted from the radio station

PATENT-ASSIGNEE: NIPPON TELEGRAPH & TELEPHONE CORP[NITE]

PRIORITY-DATA: 1993JP-0186371 (July 28, 1993)

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ABSTRACTED-PUB-NO: JP 07046660A

BASIC-ABSTRACT:

The synchronisation method for TDMA system makes use of multiple radio stations (12-14) which communicate among themselves using the same carrier frequency.
The radio communication equipment of every station has sections to perform transmission and reception of control signals that uses one slot in a said frame. The information which indicates the position of this slot in the frame is inserted in a slot control of control signal transmitted from a station (12). The transmission timing of the control signal corresponding to one station is made to synchronise with necessary timing of the control signal of another radio station (13) thereby performing frame synchronisation. The frame

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審査請求　未請求　請求項の数２　ＯＬ　（全 ６ 頁）

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(71)出願人　000004226
日本電信電話株式会社
東京都千代田区内幸町一丁目１番６号

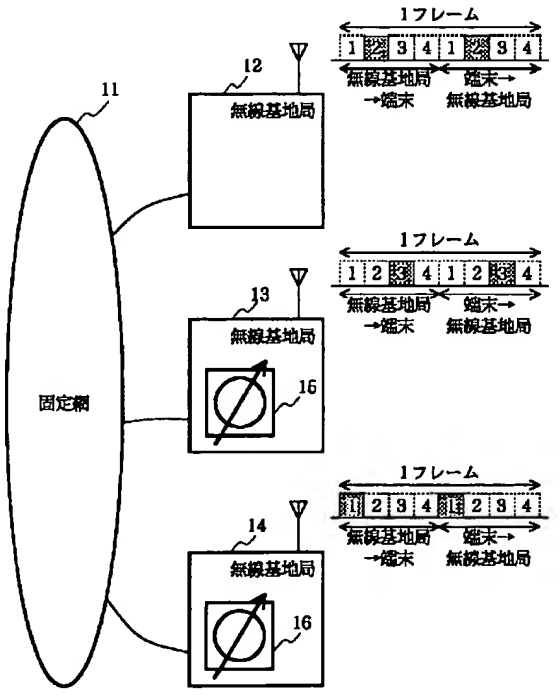
(72)発明者　友田　郁雄
東京都千代田区内幸町一丁目１番６号　日本電信電話株式会社内

(72)発明者　花澤　徹郎
東京都千代田区内幸町一丁目１番６号　日本電信電話株式会社内

(74)代理人　弁理士　井出　直孝　（外１名）

(54)【発明の名称】　無線通信装置

(57)【要約】
【目的】　ＴＤＭＡ－ＴＤＤ方式により通信を行う無線基地局間でフレーム同期を確立する。
【構成】　無線基地局１２から送信する制御信号のスロットに、そのスロットのフレーム内の位置を示す情報を挿入する。フレーム同期を行う無線基地局１３では、その制御信号の受信タイミングに自局の制御信号送信タイミングを同期させ、受信制御信号のスロットのフレーム内の位置に対応してフレーム同期を確立する。



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【特許請求の範囲】
【請求項１】　送信スロットと受信スロットとが同一キャリア周波数で時間多重されたフレームを用いて複数の移動端末と時分割多元接続方式により通信を行う複数の無線基地局を備え、
この複数の無線基地局はそれぞれ、上記フレーム内の少なくともひとつのスロットを用いて移動端末に対する制御信号の送受信を行う手段を含む無線通信装置において、
上記複数の無線基地局の少なくともひとつの無線基地局は、上記制御信号を送信するスロットにそのスロットのフレーム内の位置を示すスロット位置情報を挿入するフレーム内位置報知手段を含み、
各無線基地局における上記制御信号の受信タイミングおよびその受信したスロット位置情報にしたがってその局の送受信するフレームのタイミングを調整するフレーム同期手段を備えたことを特徴とする無線通信装置。
【請求項２】　上記複数の無線基地局のひとつが基準局に設定され、
少なくともこの基準局に上記フレーム内位置通知手段が設けられ、
上記フレーム同期手段は少なくとも上記基準局以外のすべての無線基地局に設けられた請求項１記載の無線通信装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は時分割多元接続通信方式に利用する。特に送受信のスロットを同一キャリア周波数で時間多重する通信方式、すなわちＴＤＭＡ－ＴＤＤ方式に関する。本発明は、マルチゾーン形のディジタル・コードレス電話に利用するに適する。
【０００２】
【従来の技術】図８はＴＤＭＡ－ＴＤＤ方式の従来例の無線通信装置を示すブロック構成図であり、図１０はそのフレーム構造の一例を示す。
【０００３】この無線通信装置は、固定網８１に接続された無線基地局８２を備え、この無線基地局８２が複数の移動端末とＴＤＭＡ－ＴＤＤ方式により通信を行う。ＴＤＭＡ－ＴＤＤ方式では、ひとつのフレームが、送信スロットをｎ個多重する送信スロット側と、受信スロットをｎ個多重する受信スロット側とから構成される。
【０００４】ここで、無線基地局８２と移動端末８３および８４との間の通信について説明する。無線基地局８２は、あらかじめ定められたスロット、この例では第１スロットを用いて、回線設定を行うために必要な情報を含む制御信号を送信する。制御信号のキャリア周波数としてはｆ１を使用する。無線基地局８２はさらに、移動端末８３への通話信号を第２スロットにより送信し、移動端末８４への通話信号を第３スロットにより送信する。通話信号のキャリア周波数としては、ｆ１とは異なる周波数を使用する。さらに、その他の移動端末に対して第４スロット以降を用いて通話信号を送信する。移動端末８３、８４、…では、自分の受信スロットからあらかじめ定められた時間が経過した後に、無線基地局８２へ電話信号を送信する。無線基地局８２では、各移動端末からの信号が、１フレーム内の送信スロットに対応する受信スロット位置で受信される。

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【０００５】この例では無線基地局がひとつの場合を示したが、複数の無線基地局を設けるような用途、例えばマルチゾーン形のコードレス電話のような用途では、制御信号の衝突が生じないように無線基地局間の同期をとる必要がある。
【０００６】無線基地局間の同期合わせの例として、図１０に従来の自動車電話装置の例を示す。ただし、この場合にはＴＤＭＡ方式もＴＤＤ方式も用いられておらず、同時にアクセスできる無線チャネルは一つであり、送受信の無線チャネルが周波数により多重されている。
【０００７】この自動車電話装置は、固定網１０１に接続された制御局１０２を備え、この制御局１０２に無線基地局１０５～１０７が接続される。制御局１０２には伝搬遅延を調整するための可変遅延回路１０３、１０４が設けられる。移動端末１０８に対する制御信号は、制御局１０２から無線基地局１０５～１０７を介して送出される。無線基地局１０５～１０７は、互いのゾーンが重ならないように設定された周波数を用いて、互いに同期して制御信号を送出する。
【０００８】制御信号を同期させるためには、例えば無線基地局１０５を基準局とし、無線基地局１０６では無線基地局１０５からの制御信号を受信して自局の送信タイミングとの時間差を測定する。この測定結果を制御局１０２に通知し、制御局１０２では対応する可変遅延回路１０３を調整して時間差が零となるようにする。無線基地局１０７では、無線基地局１０６からの制御信号を受信して自局の送信タイミングとの時間差を測定し、その結果を制御局１０２に通知する。制御局１０２は、時間差が零となるように対応する可変遅延回路１０４を調整する。
【０００９】図１１は制御局１０２および無線基地局１０５～１０７による制御信号の送出タイミングを示す。制御局１０２では、可変遅延回路１０３、１０４により制御信号を遅延させ、無線基地局１０５～１０７に対してそれぞれ時刻ｔ０～ｔ２のタイミングで制御信号を送出する。これらの制御信号は、制御局１０２と無線基地局１０５～１０７との間の信号線を通過することにより伝搬遅延が生じ、無線基地局１０５～１０７からは時刻ｔ３に一斉に送信される。
【００１０】このようにして、複数の無線基地局から送信された制御信号がほぼ同時に移動端末に到達し、無線基地局からの制御信号が同レベルで受信されるような無線基地局相互間の境界域を通過する場合にも、移動端末

ではその同期状態を保ちながらその相手先の無線基地局を切り替えることができる。

【００１１】

【発明が解決しようとする課題】複数の無線基地局が制御信号を互いに異なる周波数で送信する場合には、個々の無線基地局で他の無線基地局からの制御信号を受信することで、それぞれの局の送信タイミングを設定することができる。

【００１２】しかし、ＴＤＭＡ－ＴＤＤ方式の場合には、同一周波数を使用しているので、無線基地局が互いに異なるタイミングで制御信号を送信する必要がある。それでいて、各無線基地局が移動端末との間で送受信する信号のフレームは、少なくとも隣接する無線基地局間では同期している必要がある。同期していなければ、一方の無線基地局が送信のときもう一方が受信となり、干渉によって通信品質の劣化および周波数利用効率の低下を招くからである。したがって、従来の自動車電話装置のような方法をそのまま利用することはできない。

【００１３】本発明は、ＴＤＭＡ－ＴＤＤ方式における無線基地局間で制御信号送信タイミングを同期させることのできる無線通信装置を提供することを目的とする。

【００１４】

【課題を解決するための手段】本発明の無線通信装置は、送信スロットと受信スロットとが同一キャリア周波数で時間多重されたフレームを用いて複数の移動端末と時分割多元接続方式により通信を行う複数の無線基地局を備え、この複数の無線基地局はそれぞれ、フレーム内の少なくともひとつのスロットを用いて移動端末に対する制御信号の送受信を行う手段を含む無線通信装置において、複数の無線基地局の少なくともひとつの無線基地局は、制御信号を送信するスロットにそのスロットのフレーム内の位置を示すスロット位置情報を挿入するフレーム内位置報知手段を含み、各無線基地局における制御信号の受信タイミングおよびその受信したスロット位置情報にしたがってその局の送受信するフレームのタイミングを調整するフレーム同期手段を備えたことを特徴とする。

【００１５】複数の無線基地局のひとつを基準局に設定し、少なくともこの基準局、場合によってはすべての基準局にフレーム内位置通知手段を設け、フレーム同期手段を基準局以外のすべての無線基地局に設けることがよい。

【００１６】各無線基地局のフレーム同期を順番に確立することも可能である。しかし、フレーム同期を確立するためには他の無線基地局からの制御信号を受信する必要があり、その無線基地局におけるフレーム送受信を中断しなければならない。したがって、制御信号が到達する範囲内に設置されている限り、ひとつの無線基地局からの制御信号により他の無線基地局が一斉にフレーム同期動作を実行することが望ましい。

【００１７】

【作用】少なくともひとつの無線基地局から送信する制御信号のスロットに、そのスロットのフレーム内の位置を示す情報を挿入する。フレーム同期を行う無線基地局では、その制御信号および位置の情報を受信し、その制御信号のタイミングおよびそのスロット位置を参照して、自局のフレーム送受信タイミングを設定する。これにより、その局の制御信号の送信タイミングも設定される。

【００１８】コードレス電話のような小型の無線通信装置では、無線基地局と固定網間との間に制御局を接続する構成では配線が複雑となるので、無線基地局を個別に固定網に接続し、個々の無線基地局で固定網と無線基地局との間の伝搬遅延を補正することが望ましい。

【００１９】

【実施例】図１は本発明実施例の無線通信装置を示すブロック構成図である。この実施例装置は、送信スロットと受信スロットとが同一キャリア周波数で時間多重されたフレームを用いて複数の移動端末と時分割多元接続方式により通信を行う複数の無線基地局１２～１４を備え、この複数の無線基地局１２～１４はそれぞれ、フレーム内の少なくともひとつのスロットを用いて移動端末に対する制御信号の送受信を行う。以下では、無線基地局１２～１４がそれぞれ、第２、第３、第１タイムスロットを利用して制御信号の送受信を行うものとして説明する。

【００２０】図２は制御信号スロットのフォーマット例を示す。このスロットは、信号の立ち上がりに使用する４ビットのランプビットＲと、スタートビットに使用する２ビットのスタートシンボルＳＳと、ビット同期の確立に使用する６２ビットのプリアンブルＰＲと、フレーム同期の確立に使用する３２ビットのユニークワードＵＷと、実際の制御信号を伝送するための１２４ビットのＣＡＣと、タイムスロット間の衝突防止に使用する１６ビットの無信号のガードビットＧとにより構成される。

【００２１】通常の動作状態では、無線基地局１２～１４の送受信のタイミングは同期しており、無線基地局１２～１４の送信する制御信号が他の無線基地局で受信されることはない。しかし、運用開始時あるいはその他のタイミング調整時には、無線基地局１３、１４の送受信タイミングを無線基地局１２の送受信タイミングに同期させる必要がある。このためには、本来は移動端末から制御信号を受信するための機能を利用し、無線基地局１２の送信した制御信号を受信する。

【００２２】図３は無線基地局１３における同期動作の流れを示すフローチャートである。無線基地局１２は、図２に示したユニークワードＵＷのビットパターンにより、またはＣＡＣに専用の２ビットを設けることにより、そのスロットのフレーム内の位置を示す信号を送信する。無線基地局１２は、このスロットを受信すると、

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プリアンブルＰＲによりビット同期を確立し、ユニークワードＵＷによりスロットについてのフレーム同期を確立する。このとき、受信タイミングと自局が制御信号を送信しようとするタイミングとの時間差を測定し、まず、その時間差が零となるように可変遅延回路１５を調整する。続いて、そのスロットで受信した制御信号を復号し、受信したスロットのフレーム内の位置を確認して、１フレーム内の遅延時間差が零とするように再び可変遅延回路１５を調整する。このようにして同期が確立した後に、無線基地局１３が制御信号の送信を開始する。

【００２３】無線基地局１４も同様に、無線基地局１２からの制御信号にしたがって可変遅延回路１６を調整してフレーム同期を確立し、制御信号の送出を開始する。無線基地局１４の設置場所が無線基地局１２からの制御信号の到達しない場所であれば、無線基地局１３からの制御信号にしたがってフレーム同期を確立する。

【００２４】図４ないし図７は動作例を示す。図４はフレーム同期が確立する前の状態を示す。この状態では、無線基地局１２の送信と無線基地局１３、１４の受信とが重なったり、制御信号が衝突する可能性がある。そこで、まず、図５に示すように、自局（この例では無線基地局１３）の制御信号送信のタイミングを他の無線基地局（この例では無線基地局１２）からの制御信号の受信タイミングに同期させる。続いて、その制御信号で示されたそのスロットのフレーム内の位置に基づいて、同じ番号のスロットが同期するように、自局の送受信するフレームのタイミングを調整する。図６は無線基地局１２、１３間でフレーム同期が確立した状態を示し、図７はすべての無線基地局１２～１４でフレーム同期が確立した状態を示す。

【００２５】以上の実施例では、基準局となる無線基地局１２の構成を他の無線基地局１３、１４とは別のものとして示したが、一般には同一構成のものを用いることがでる。

【００２６】

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【発明の効果】以上説明したように、本発明の無線通信装置は、少なくともひとつの無線基地局から送信する制御信号のスロットにそのフレーム内での位置に関する情報を挿入することにより、ＴＤＭＡ－ＴＤＤ方式における無線基地局間でフレーム同期を確立することができる。したがって、一方の無線基地局が送信のときにもう一方も送信となり、一方の無線基地局が受信のときにもう一方も受信となって、通信品質を高めることができ、しかも周波数有効率を高めることができる。

【図面の簡単な説明】

【図１】本発明実施例の無線通信装置を示すブロック構成図。

【図２】制御信号スロットのフォーマット例を示す図。

【図３】ひとつの無線基地局における同期動作の流れを示すフローチャート。

【図４】動作例を示す図であり、フレーム同期が確立する前の状態を示す図。

【図５】動作例を示す図であり、制御信号のタイミングが同期した状態を示す図。

【図６】二つの無線基地局間でフレーム同期が確立した状態を示す図。

【図７】すべての無線基地局でフレーム同期が確立した状態を示す図。

【図８】ＴＤＭＡ－ＴＤＤ方式の従来例の無線通信装置を示すブロック構成図。

【図９】フレーム構成を示す図。

【図１０】従来の自動車電話装置を示すブロック構成図であり、その無線基地局間の同期合わせを説明する図。

【図１１】制御局および無線基地局による制御信号の送出タイミングを示す図。

【符号の説明】

１１、８１、１０１　固定網

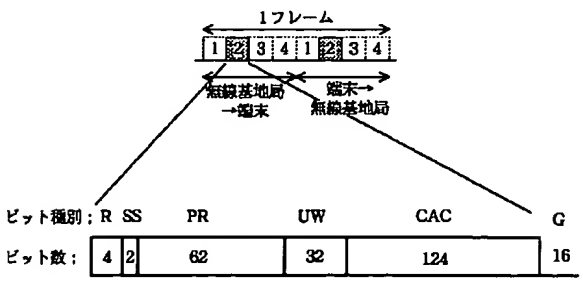
１２～１４、８２、１０５～１０７　無線基地局

１５、１６、１０３、１０４　可変遅延回路

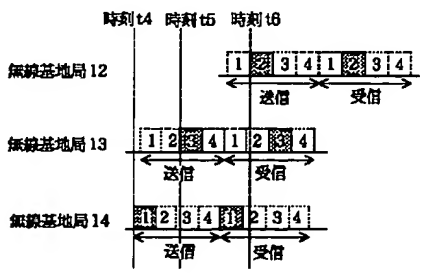
８３、８４、１０８　移動端末

１０２　制御局

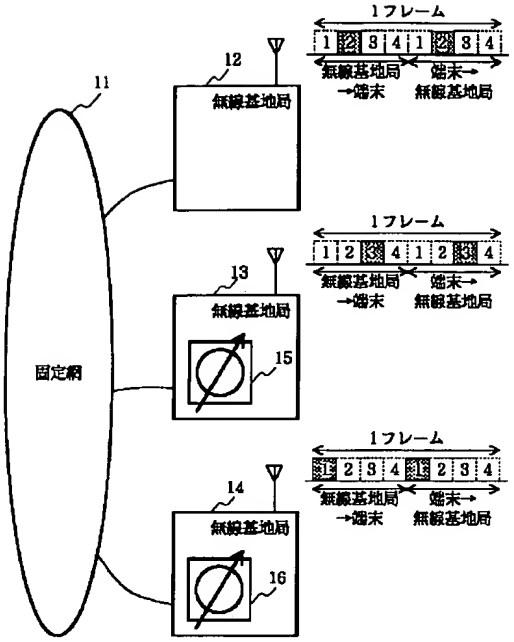
【図２】



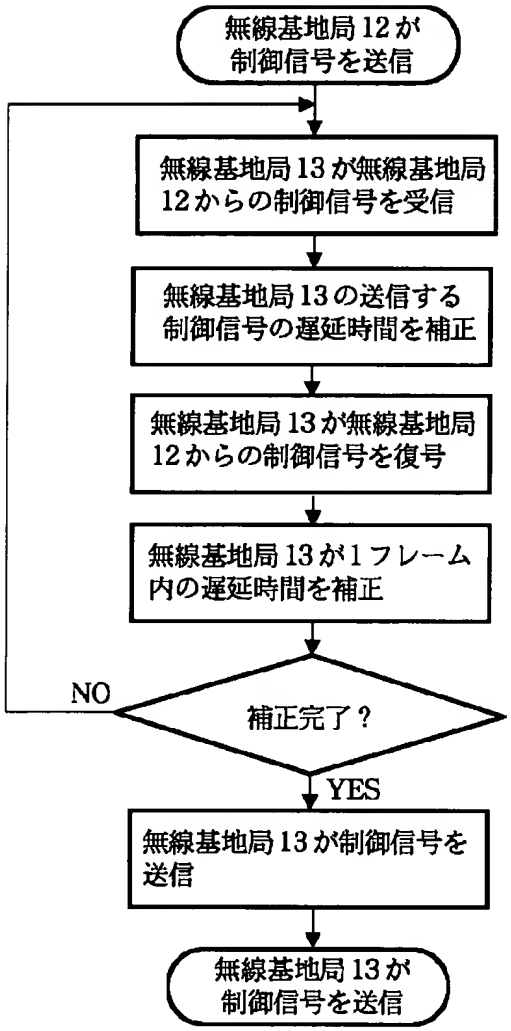
【図４】



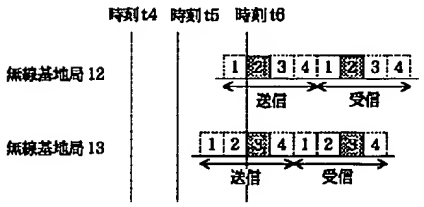
【図1】


1フレーム
1 2 3 4 1 2 3 4
無線基地局→端末
端末→無線基地局
11
12
無線基地局
13
無線基地局
14
無線基地局
15
16
固定網

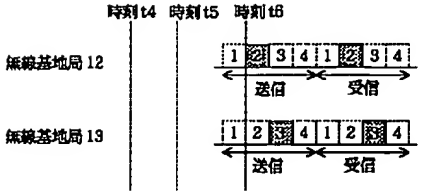
【図3】


無線基地局12が制御信号を送信
無線基地局13が無線基地局12からの制御信号を受信
無線基地局13の送信する制御信号の遅延時間を補正
無線基地局13が無線基地局12からの制御信号を復号
無線基地局13が1フレーム内の遅延時間を補正
補正完了？
NO
YES
無線基地局13が制御信号を送信
無線基地局13が制御信号を送信

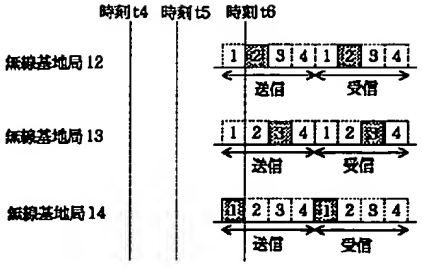
【図5】


時刻t4 時刻t5 時刻t6
無線基地局12
無線基地局13
1 2 3 4 1 2 3 4
送信
受信

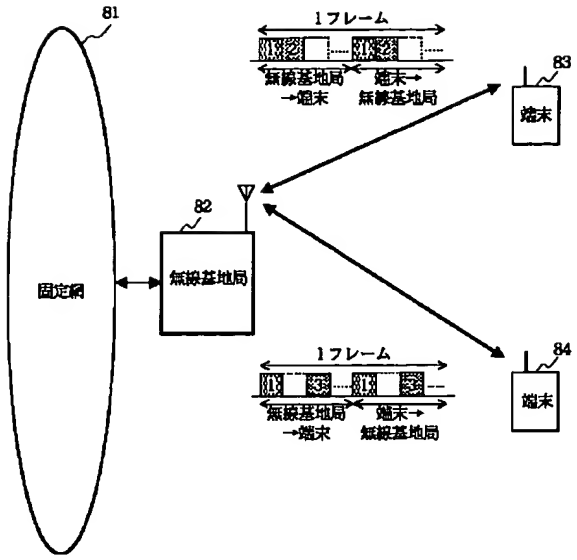
【図6】


時刻t4 時刻t5 時刻t6
無線基地局12
無線基地局13
1 2 3 4 1 2 3 4
送信
受信

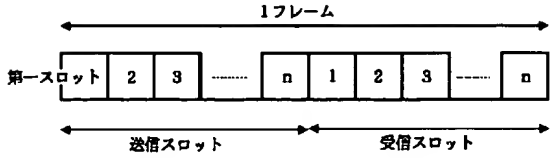
【図7】


時刻t4 時刻t5 時刻t6
無線基地局12
無線基地局13
無線基地局14
1 2 3 4 1 2 3 4
送信
受信

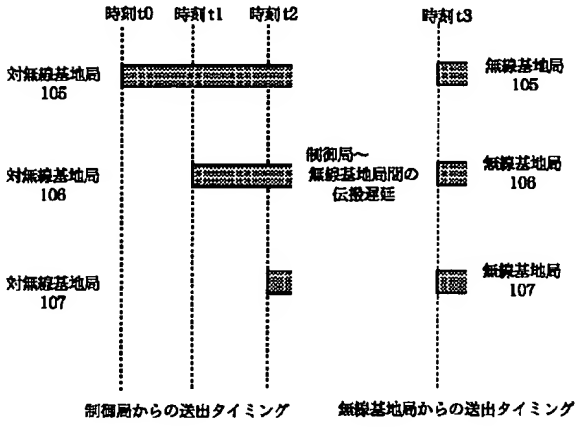
【図8】


81
1フレーム
無線基地局→端末
端末→無線基地局
83
端末
82
固定網
無線基地局
1フレーム
無線基地局→端末
端末→無線基地局
84
端末

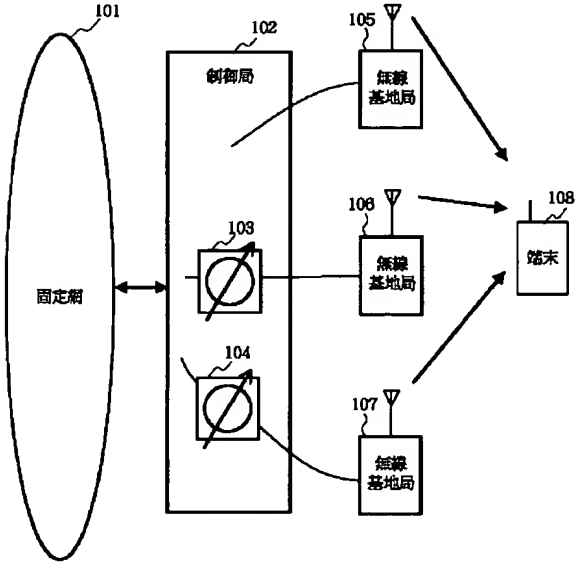
【図9】


1フレーム
第一スロット
2
3
n
1
2
3
n
送信スロット
受信スロット

【図11】


時刻t0
時刻t1
時刻t2
時刻t3
対無線基地局105
対無線基地局106
対無線基地局107
制御局～無線基地局間の伝搬遅延
無線基地局105
無線基地局106
無線基地局107
制御局からの送出タイミング
無線基地局からの送出タイミング

【図10】


101
102
制御局
105
無線基地局
103
106
無線基地局
108
端末
固定網
104
107
無線基地局

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention is used for a time division multiple access communication mode. It is related with the communication mode which carries out time multiplex [of the slot of transmission and reception] by the same carrier frequency especially, i.e., a TDMA-TDD method. this invention is suitable for using for the digital cordless telephone of a multizone form.
[0002]
[Description of the Prior Art] Drawing 8 is the block block diagram showing the radio communication equipment of the conventional example of a TDMA-TDD method, and drawing 10 shows an example of the frame structure.
[0003] This radio communication equipment is equipped with the base transceiver station 82 connected to the fixed network 81, and this base transceiver station 82 communicates with two or more move terminals and TDMA-TDD methods. One frame is constituted from the receiving slot side which carries out n piece multiplex [of the receiving slot] the transmitting slot side which carries out n piece multiplex [of the transmitting slot] by the TDMA-TDD method.
[0004] Here, communication between a base transceiver station 82 and the move terminals 83 and 84 is explained. A base transceiver station 82 transmits a control signal including information required in order to perform a circuit setup using the 1st slot in the slot defined beforehand and this example. f1 is used as a carrier frequency of a control signal. Further, a base transceiver station 82 transmits the telephone call signal to the move terminal 83 by the 2nd slot, and transmits the telephone call signal to the move terminal 84 by the 3rd slot. Different frequency from f1 is used as a carrier frequency of a telephone call signal. Furthermore, a telephone call signal is transmitted using the 4th slot or subsequent ones to other move terminals. In the move terminals 83 and 84 and --, after the time beforehand set from its receiving slot passes, a telephone signal is transmitted to a base transceiver station 82. In a base transceiver station 82, the signal from each move terminal is received in the receiving slot position corresponding to the transmitting slot in one frame.
[0005] Although this example showed the case where the number of base transceiver stations was one, it is necessary to take the synchronization between base transceiver stations for a use which prepares two or more base transceiver stations, for example, a use like the cordless telephone of a multizone form, so that the collision of a control signal may not arise.
[0006] As an example of synchronous doubling between base transceiver stations, the example of conventional car telephone equipment is shown in drawing 10 . However, a TDMA method or TDD method is not used in this case, either, but the number of the radio channels which can be accessed simultaneously is one, and multiplex [of the radio channel of transmission and reception] is carried out by frequency.
[0007] This car telephone equipment is equipped with the control station 102 connected to the fixed network 101, and base transceiver stations 105-107 are connected to this control station 102. The adjustable delay circuits 103 and 104 for adjusting a propagation delay are formed in a control station 102. The control signal to the move terminal 108 is sent out through base transceiver stations 105-107 from a control station 102. Using the frequency set up so that a mutual zone might not lap, base transceiver stations 105-107 synchronize mutually, and send out a control signal.
[0008] In order to synchronize a control signal, a base transceiver station 105 is made into a criteria office, the control signal from a base transceiver station 105 is received, and time difference with the transmit timing of a local station is measured in a base transceiver station 106. This measurement result is notified to a control station 102, and the corresponding adjustable delay circuit 103 is adjusted and it is made for time difference to serve as zero in a control station 102. In a base transceiver station 107, the control signal from a base transceiver station 106 is received, time difference with the transmit timing of a local station is measured, and the result is notified to a control station 102. A control station 102 adjusts the adjustable delay circuit 104 which corresponds so that time difference may serve as zero.

[0009] Drawing 11 shows the sending-out timing of the control signal by the control station 102 and base transceiver stations 105-107. In a control station 102, a control signal is delayed by the adjustable delay circuits 103 and 104, and the timing of time t0-t2 sends out a control signal to base transceiver stations 105-107 by it, respectively. By passing the signal line between a control station 102 and base transceiver stations 105-107, a propagation delay arises and these control signals are transmitted to time t3 all at once from base transceiver stations 105-107.
[0010] Thus, the control signal transmitted from two or more base transceiver stations reaches a move terminal almost simultaneous, and when passing through a boundary region between base transceiver stations where the control signal from a base transceiver station is received on this level, at a move terminal, the base transceiver station of the partner point can be changed, maintaining the synchronous state.
[0011]
[Problem(s) to be Solved by the Invention] When two or more base transceiver stations transmit a control signal on mutually different frequency, the transmit timing of each office can be set up by receiving the control signal from other base transceiver stations in each base transceiver station.
[0012] However, in the case of a TDMA-TDD method, since the same frequency is used, a base transceiver station needs to transmit a control signal to mutually different timing. And yet, the frame of the signal which each base transceiver station transmits and receives between move terminals needs to synchronize among the base transceiver stations which adjoin at least. It is because another side is received and causes degradation of communication quality, and decline in frequency use efficiency by interference, when one base transceiver station is transmission, if it does not synchronize. Therefore, a method like conventional car telephone equipment cannot be used as it is.
[0013] this invention aims at offering the radio communication equipment which can synchronize control signal transmit timing among the base transceiver stations in a TDMA-TDD method.
[0014]
[Means for Solving the Problem] The radio communication equipment of this invention is equipped with two or more base transceiver stations where a transmitting slot and a receiving slot communicate by two or more move terminals and Time Division Multiple Accesses using the frame by which time multiplex was carried out by the same carrier frequency. In the radio communication equipment in which two or more of these base transceiver stations include a means to transmit and receive the control signal to a move terminal using at least one slot in a frame, respectively At least one base transceiver station of two or more base transceiver stations A position information means in a frame to insert the slot positional information which shows the position in the frame of the slot in the slot which transmits a control signal is included. It is characterized by having a frame synchronization means to adjust the timing of the frame which the office transmits and receives according to the receiving timing and its slot positional information which received of the control signal in each base transceiver station.
[0015] It is good to set one of two or more of the base transceiver stations as a criteria office, to prepare the notice means of the position in a frame in all criteria offices at least depending on this criteria office and the case, and to prepare all base transceiver stations other than a criteria office a frame synchronization means.
[0016] It is also possible to establish the frame synchronization of each base transceiver station in order. However, in order to establish frame synchronization, it is necessary to receive the control signal from other base transceiver stations, and you have to interrupt the frame transmission and reception in the base transceiver station. Therefore, as long as it is installed within limits which a control signal reaches, it is desirable for other base transceiver stations to perform frame synchronization operation all at once with the control signal from one base transceiver station.
[0017]
[Function] The information which shows the position in the frame of the slot is inserted in the slot of the control signal transmitted from at least one base transceiver station. In the base transceiver station which performs frame synchronization, the control signal and the information on a position are received, and the frame transceiver timing of a local station is set up with reference to the timing and its slot position

of the control signal. Thereby, the transmit timing of the control signal of the office is also set up.
[0018] since wiring becomes complicated at a small radio communication equipment like a cordless telephone with the composition which connects a control station between a base transceiver station and a fixed network -- a base transceiver station -- individual -- a fixed network -- connecting -- each base transceiver station -- the propagation delay between a fixed network and a base transceiver station -- an amendment -- things are desirable
[0019]
[Example] Drawing 1 is the block block diagram showing the radio communication equipment of this invention example. This example equipment is equipped with two or more base transceiver stations 12-14 where a transmitting slot and a receiving slot communicate by two or more move terminals and Time Division Multiple Accesses using the frame by which time multiplex was carried out by the same carrier frequency, and the control signal to a move terminal is transmitted [two or more of these base transceiver stations 12-14] and received using at least one slot in a frame, respectively. Below, base transceiver stations 12-14 explain as what transmits and receives a control signal using the 2nd, the 3rd, and the 1st time slot, respectively.
[0020] Drawing 2 shows the example of a format of a control signal slot. This slot is constituted by the guard bit G of the 16-bit non-signal used for the 62 bits preamble PR used for establishment of the 2-bit start symbol SS and bit synchronization which are used for the 4-bit lamp bit R used for the standup of a signal, and a start bit, 32 bits unique WORD UW used for establishment of frame synchronization, 124-bit CAC for transmitting an actual control signal, and the collision prevention between time slots.
[0021] In a normal operating state, the timing of transmission and reception of a base transceiver station 12-14 synchronizes, and the control signal which base transceiver stations 12-14 transmit is not received in other base transceiver stations. However, it is necessary to synchronize the transceiver timing of base transceiver stations 13 and 14 with the transceiver timing of a base transceiver station 12 at the time of an employment start or other timing adjustments. For that, the function for originally receiving a control signal from a move terminal is used, and the control signal which the base transceiver station 12 transmitted is received.
[0022] Drawing 3 is a flow chart which shows the flow of the synchronous operation in a base transceiver station 13. A base transceiver station 12 transmits the signal which shows the position in the frame of the slot the bit pattern of unique WORD UW shown in drawing 2 , or by preparing 2 bits of exclusive use in CAC. If this slot is received, a base transceiver station 12 will establish a bit synchronization by Preamble PR, and will establish the frame synchronization about a slot by unique WORD UW. At this time, the time difference of receiving timing and the timing to which a local station tends to transmit a control signal is measured, and first, the adjustable delay circuit 15 is adjusted so that the time difference may serve as zero. Then, the position in the frame of the slot which the control signal received by the slot was decoded, and was received is checked, and the adjustable delay circuit 15 is again adjusted so that the time delay difference in one frame may consider as zero. Thus, after a synchronization is established, a base transceiver station 13 starts transmission of a control signal.
[0023] Similarly, a base transceiver station 14 also adjusts the adjustable delay circuit 16 according to the control signal from a base transceiver station 12, establishes frame synchronization, and starts sending out of a control signal. If the installation of a base transceiver station 14 is a place at which the control signal from a base transceiver station 12 does not arrive, frame synchronization will be established according to the control signal from a base transceiver station 13.
[0024] Drawing 4 or drawing 7 shows an example of operation. Drawing 4 shows the state before frame synchronization is established. In this state, transmission of a base transceiver station 12 and reception of base transceiver stations 13 and 14 may lap, or a control signal may collide. Then, first, as shown in drawing 5 , the timing of control signal transmission of a local station (this example base transceiver station 13) is synchronized with the receiving timing of the control signal from other base transceiver stations (this example base transceiver station 12). Then, based on the position in the frame of the slot shown with the control signal, the timing of the frame which a local station transmits and receives is adjusted so that the slot of the same number may synchronize. Drawing 6 shows a base transceiver

station 12 and the state where frame synchronization was established among 13, and drawing 7 shows the state where frame synchronization was established in all the base transceiver stations 12-14.
[0025] Although other base transceiver stations 13 and 14 showed the composition of the base transceiver station 12 which turns into a criteria office as another thing in the above example, using the thing of the same composition generally comes out.
[0026]
[Effect of the Invention] As explained above, the radio communication equipment of this invention can establish frame synchronization among the base transceiver stations in a TDMA-TDD method by inserting the information about the position within the frame in the slot of the control signal transmitted from at least one base transceiver station. Therefore, when one base transceiver station is transmission, another side is also transmitted, and when one base transceiver station is reception, another side can also be received, can raise communication quality, and, moreover, can raise the rate of frequency effective.

RWS Group plc, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England, hereby declares that, to the best of its knowledge and belief, the following document, prepared by one of its translators competent in the art and conversant with the English and Japanese languages, is a true and correct translation of the accompanying document in the Japanese language.

Signed this 15th day of October 2003

S. ANTHONY

Director

For and on behalf of RWS Group plc

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(71) Applicant 000004226
Nihon Denshin Denwa K.K (NTT)
1-1-6 Saiwai-cho, Chiyoda-ku, Tokyo

(72) Inventor: I. Tomota
at Nihon Denshin Denwa K.K (NTT)
1-1-6 Saiwai-cho, Chiyoda-ku, Tokyo

(72) Inventor: T. Hanasawa
at Nihon Denshin Denwa K.K (NTT)
1-1-6 Saiwai-cho, Chiyoda-ku, Tokyo

(74) Agent Patent Attorney N. Ide (and one other)

(54) (Title of Invention) Wireless communication device

(57) (Summary)

(Purpose) To establish frame synchronisation between wireless base stations which communicate using the TDMA-TDD system.

(Constitution) Data is inserted into the slot of a control signal sent from wireless base station 12 indicating the position of this slot within the frame. At wireless base station 13 where frame synchronisation is carried out, the timing of the transmission of its own control signal is synchronised to the timing of the received control signal, thus establishing frame synchronisation in correspondence with the position within the frame of the slot of the received control signal.

(Claims)

(Claim 1) In a wireless communication device provided with a plurality of mobile terminals which employ frames with transmitted slots and received slots multiplexed through time at the same carrier frequency, and a plurality of wireless base stations which communicate using the time division multiple access system,

and in which the plurality of wireless base stations respectively include a means of transmitting and receiving control signals for the mobile terminals using at least one slot within said frame,

a wireless communication device characterised in that at least one of the wireless base stations amongst said plurality of wireless base stations includes a frame position notification means which inserts slot position data showing the position of the slot within the frame into the slot which transmits said control signal,

and in being provided with a frame synchronisation means which adjusts the timing of frames transmitted and received by that station in accordance with the timing of said control signals received from each wireless base station and the received slot position data.

(Claim 2) A wireless communication device as claimed in Claim 1 in which a reference station is established in one of the said plurality of wireless base stations,

said frame position notification means being established at least within this reference station,

and said frame synchronisation means being provided in at least all of the wireless base stations other than said reference station.

(Detailed Description)

(0001)

(Field of Industrial Use) The invention is employed in a time division multiple access communication system. In particular it relates to a communication system in which transmitted and received slots are multiplexed through time at the same carrier frequency, in other words a TDMA-TDD system. The invention is suitable for use with multizone-type digital cordless telephones.

(0002)

(Prior Art) Fig. 8 is a block diagram showing the structure of a conventional wireless communication device employing the TDMA-TDD system, and Fig. 10 shows an example of the structure of a frame.

(0003) With this wireless communication system, a wireless base station 82 connected to fixed network 81 is provided, this wireless base station 82 communicating with a plurality of mobile terminals using the TDMA-TDD system. With the TDMA-TDD system, a single frame comprises a transmitted slot side in which n transmitted slots are multiplexed and a received slot side in which n received slots are multiplexed.

(0004) The communication between wireless base station 82 and mobile terminals 83 and 84 will now be described. Wireless base station 82 employs a predetermined slot, in this example the first slot, to transmit a control signal which includes the necessary data for establishing a link. The carrier wave used for the control signal is f1. Furthermore, wireless base station 82 transmits communication signals to mobile terminal 83 using the second slot, and communication signals to mobile terminal 84 using the third slot. The carrier frequency for the communication signals is a different frequency to f1. Moreover, the fourth and successive slots can be employed for communication signals to other mobile terminals. Mobile terminals 83, 84 transmit a telephone number to wireless base station 82 after a predetermined time has elapsed after their own received slot. At wireless base station 82, signals from each mobile terminal are received at the received slot position corresponding to the transmitted slot within one frame.

(0005) In this example, a single wireless base station has been employed, but where a plurality of wireless base stations are provided, for example when using a multizone type cordless telephone, it is necessary for the wireless base stations to be synchronised in order to prevent clashes between control signals.

(0006) To illustrate synchronisation between wireless base stations, Fig. 10 shows an example of a conventional automobile telephone device. However, in this case, neither the TDMA system or the TDD system are employed, and only one wireless channel can be accessed at a time, the incoming and outgoing wireless channels being multiplexed by frequency.

(0007) With this automobile telephone device, control station 102 connected to fixed network 101 is provided, wireless base stations 105-107 being connected to this control station 102. Variable delay circuits 103,104 are provided on control station 102 in order to adjust the delay in transmission. The control signal for mobile terminal 108 is transmitted via wireless base stations 105-107 from control station 102. Wireless base stations 105-107 employ fixed frequencies so that their zones do not overlap, and transmit a mutually synchronised control signal.

(0008) In order to synchronise the control signal, with wireless base station 105 as the reference station for example, the control signal from wireless base station 105 is received at wireless base station 106 and the time difference with its own transmission timing is measured. The result of this measurement is communicated to control station 102, and, at control station 102, the corresponding variable delay circuit 103 is adjusted so that the time difference goes to zero. At wireless base station 107, the control signal from wireless base station 106 is received, and the time difference with its own transmission timing is measured, the result of this being communicated to control station 102. At control station 102, the corresponding variable delay circuit 104 is adjusted so that the time difference goes to zero.

(0009) Fig. 11 shows the transmission timing for the control signal from control station 102 and wireless base stations 105-107. At control station 102, the control signals from variable delay circuit 103,104 are delayed, and control signals are transmitted at times t0-t2 respectively to wireless base stations 105-107. These control signals are subject to a transmission delay due to being communicated through signal wires between control station 102 and wireless base stations 105 to 107 and are transmitted simultaneously from wireless base stations 105-107 at time t3.

(0010) In this way, control signals transmitted from a plurality of wireless base stations are received more or less simultaneously at the mobile terminals, and so, even where passing through a mutual boundary zone between the wireless base stations designed to ensure the control signals from the wireless base stations are received at the same level, it is possible to switch between the wireless base stations whilst maintaining synchronisation between the mobile terminals.

(0011)

(Difficulties to Be Resolved by the Invention) Where a plurality of wireless base stations transmit control signals of differing frequencies to one another, it is possible to set up transmission timings for the respective stations by arranging for each of the wireless base stations to receive a control signal from the other wireless base stations.

(0012) However, as the TDMA-TDD system uses the same frequency, there is a need for the wireless base stations to send control signals at different timings to one another. With this in mind, the signal frames transmitted and received between the wireless base stations and mobile terminals must be synchronised at least between adjacent wireless base stations. If they are not synchronised, when one of the base stations is transmitting, the other will be receiving, which is likely to lead to a deterioration in transmission quality due to interference, or a reduction in the efficiency of use of the frequency. It is thus not possible to use the system used in the conventional automobile telephone device without modification.

(0013) The invention has the purpose of providing a wireless communication device capable of synchronising the control signal transmission timing between wireless base stations using the TDMA-TDD system.

(0014)

(Means of Resolving the Difficulties) In a wireless communication device provided with a plurality of mobile terminals which employ frames with transmitted slots and received slots multiplexed through time at the same carrier frequency, and a plurality of wireless base stations which communicate using the time division multiple access system, and in which the plurality of wireless base stations respectively include a means of transmitting and receiving control signals for the mobile terminals using at least one slot within said frame, the wireless communication device of the invention is characterised in that at least one of the wireless base stations amongst said plurality of wireless base stations includes a frame position notification means which inserts slot

position data showing the position of the slot within the frame into the slot which transmits said control signal, and in being provided with a frame synchronisation means which adjusts the timing of frames transmitted and received by that station in accordance with the timing of said control signals received from each wireless base station and the received slot position data.

(0015) With one of said plurality of wireless base stations established as a reference station, it is preferable that a frame position notification means be provided at least in this reference station, and, where appropriate, in all the reference stations, with a frame synchronisation means being provided in all of the wireless base stations other than the reference station.

(0016) The synchronisation of each wireless base station frame may be set up sequentially. However, in order to establish frame synchronisation, it is necessary to receive a control signal from other wireless base stations, and transmission and reception of frames in this wireless base station must be interrupted. Thus, as long as they are positioned within range of the control signal, it is preferable that the frame synchronisation process be executed for the other wireless base stations simultaneously using a control signal from one of the wireless base stations.

(0017)

(Action) Data indicating the position of a slot within a frame is inserted in the slot of a control signal transmitted from at least one of the wireless base stations. At the wireless base station which carries out frame synchronisation, the control signal and position data are received, and the transmission signal timing for its own frame is set with reference to the timing of this control signal and the slot position. By this means, the transmission timing for the control signal of the station is established.

(0018) With a compact wireless communication device such as the cordless phone, it is a complex procedure to have a wiring system with a structure which connects a control station between the wireless base stations and a fixed network, and so it is preferable that the wireless base stations be connected individually to a fixed network, and a correction be made for transmission delay between the fixed network and the wireless base station at each of the wireless base stations.

(0019)

(Embodiment) Fig. 1 is a block diagram showing the structure of a wireless communication device in an embodiment of the invention. The device of this embodiment is provided with a plurality of wireless base stations 12-14 which communicate using the time division multiple access system with a plurality of mobile terminals using frames multiplexed through time with the transmission slot and the receiving slot sharing the same carrier frequency, these multiple wireless base stations 12-14 respectively receiving and transmitting control signals for the mobile terminals using at least one slot within the frame. The case where wireless base stations 12-14 respectively use a second, a third and first time-slot to transmit and receive a control signal will now be described.

(0020) Fig. 2 shows an example of the slot format for a control signal. This slot comprises a 4-bit ramp bit R used to activate the signal, a 2-bit start symbol SS used as the start bit, a 62-bit preamble PR used to establish bit synchronisation, a 32-bit unique word UW used to establish frame synchronisation, a 124-bit CAC for transmitting the actual control signal, and a 16-bit non-signal guard bit G used to prevent clashes between time slots.

(0021) During normal operation, the timing of signals transmitted and received by wireless base stations 12-14 is synchronised, and control signals sent by wireless base stations 12-14 are not received by other wireless base stations. However, at the start of operations or when the other timings are being adjusted, it is necessary to synchronise the signal timing of wireless base stations 13, 14 with the signal timing of wireless base station 12. For this reason, a function normally used to receive a control signal from the mobile terminals is employed to receive the control signal sent from wireless base station 12.

(0022) Fig. 3 is a flow chart showing the flow of the synchronisation operation for wireless base station 13. Wireless base station 12 transmits a signal showing the position of this slot within the frame using the bit pattern of the unique word UW shown in Fig. 2, and by providing 2 dedicated bits in the CAC. Upon receiving this slot wireless base station 12 establishes bit synchronisation using the preamble PR, and establishes frame synchronisation for the slot using the unique word UW. At this time, it measures the time difference between the received timing and the timing that would otherwise be transmitted for its own control signal, and adjusts the variable delay circuit 15 so that the time difference goes to zero. The control signal received in this slot is then decoded, the position of the received slot within the frame confirmed,

and variable delay circuit 15 adjusted again so that the delay time difference within one frame goes to zero. In this way, after synchronisation has been established, wireless base station 13 begins transmitting a control signal.

(0023) In the same way, wireless base station 14 adjusts the variable delay circuit 16 in accordance with the control signal received from wireless base station 12, establishes frame synchronisation, and begins transmitting a control signal. If wireless base station 14 is located in a position where the control signal from wireless base station 12 cannot be received, it establishes frame synchronisation in accordance with the control signal from wireless base station 13.

(0024) Figs. 4-7 show examples of the operation. Fig. 4 shows the situation before frame synchronisation is established. In this case, the signal transmitted from wireless base station 12 overlaps with the signal received from wireless base stations 13, 14, with the possibility that the control signals will clash. Thus, as shown in Fig. 5, the timing of the transmission of the control signal from its own station (in this case wireless base station 13) is synchronised with the received timing of control signals from the other wireless base station (in this case wireless base station 12). Following this, based on the position of the slot within the frame indicated by this control signal, the timing of frames transmitted and received from its own station is adjusted so that slots with the same number are synchronised. Fig. 6 shows the situation where frame synchronisation has been established for wireless base stations 12, 13, and Fig. 7 shows the situation where frame synchronisation has been established for all of wireless base stations 12-14.

(0025) In the above embodiment, the structure of the reference station, wireless base station 12, has been shown as different to that of wireless base stations 13, 14, but in general it is possible to employ the same structure.

(0026)

(Effect of the Invention) As described above, with the wireless communication device of the invention it is possible to establish frame synchronisation between wireless base stations using the TDMA-TDD system by inserting data relating to position within a frame in the slot of a control signal transmitted from at least one wireless base station. Thus, when one wireless base station is transmitting, another one can also be transmitting, and when one wireless base station is receiving, another one can also be receiving, improving the quality of communication and moreover allowing the efficiency of the frequency to be improved.

(Brief Description of the Drawings)

(Fig. 1) Block diagram showing the structure of a wireless communication device in an embodiment of the invention
(Fig. 2) Diagram showing an example of the slot format for a control signal.
(Fig. 3) Flow chart showing the synchronisation process for a single wireless base station.
(Fig. 4) Diagram showing an example of the process before frame synchronisation is established.
(Fig. 5) Diagram showing an example of the process when the timing of control signals has been synchronised.
(Fig. 6) Diagram showing the situation where frame synchronisation has been established for two wireless base stations.
(Fig. 7) Diagram showing the situation where frame synchronisation has been established for all wireless base stations.
(Fig. 8) Block diagram showing the structure of a conventional wireless communication device using the TDMA-TDD system.
(Fig. 9) Diagram showing the structure of a frame.
(Fig. 10) Block diagram showing the structure of a conventional automobile telephone device, and describing how synchronisation is achieved for the wireless base stations.
(Fig. 11) Diagram showing the transmission timing of control signals from the control station and wireless base stations.

(Key to the Figures)

11, 81, 101: fixed network
12-14, 82, 105-107: wireless base stations
15, 16, 103,104: variable delay circuits
83, 84, 108: mobile terminals
102: control station

Figure 2

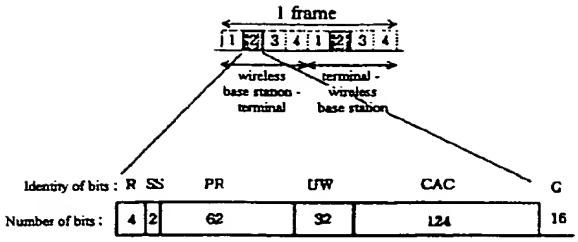

Figure 4

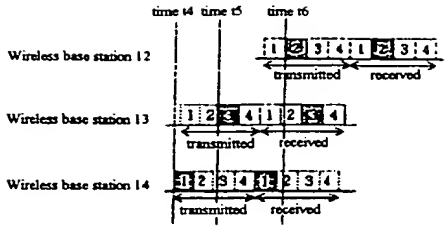

Figure 8

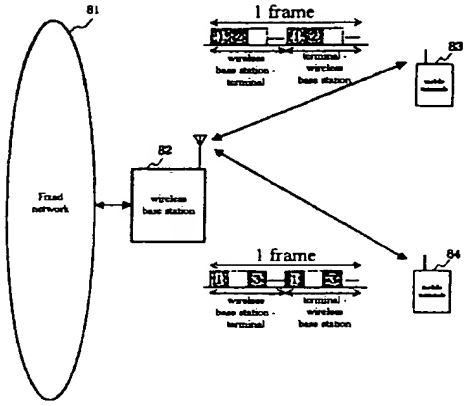

Figure 9

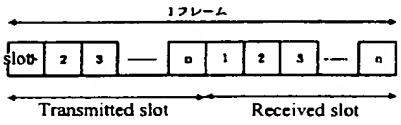

Figure 11

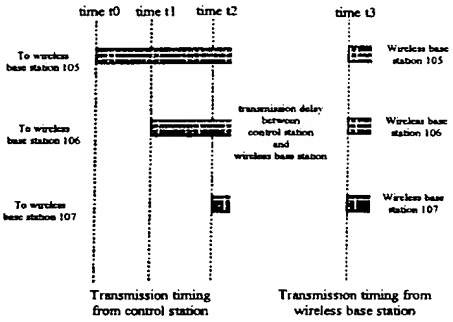

Figure 10

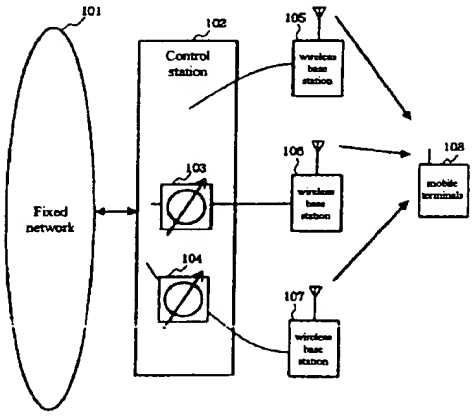

Figure 1

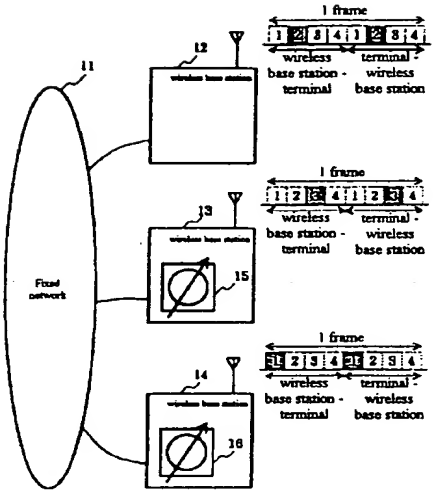

Figure 3

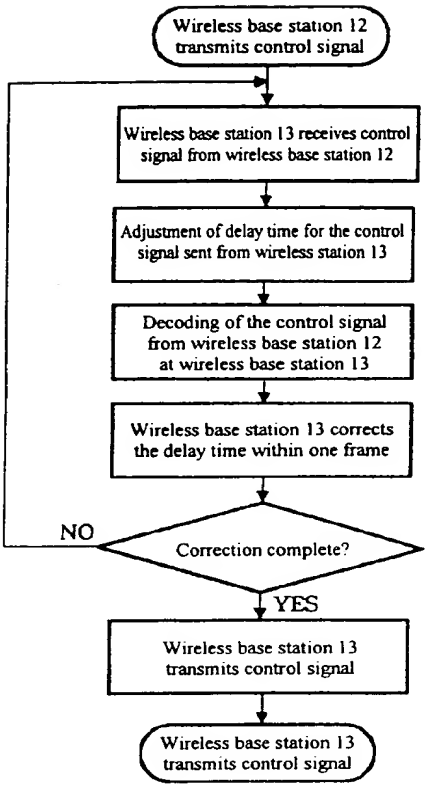

Figure 5

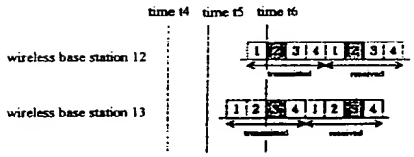

Figure 6

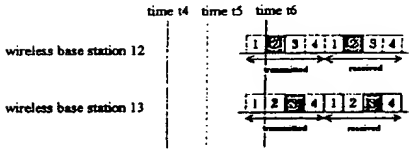

Figure 7